National Aeronautics and Space Administration

Aircraft Certification by Analysis (CbA)

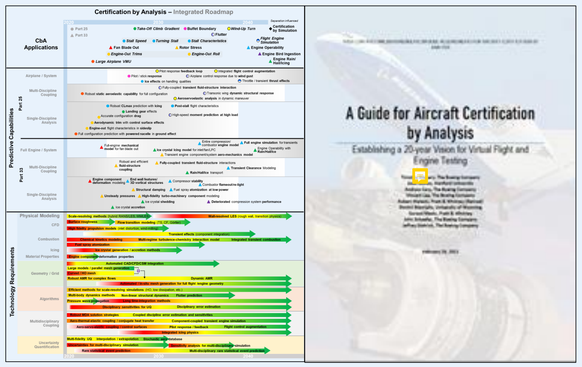
20-year Vision for Virtual Flight Testing

Challenge

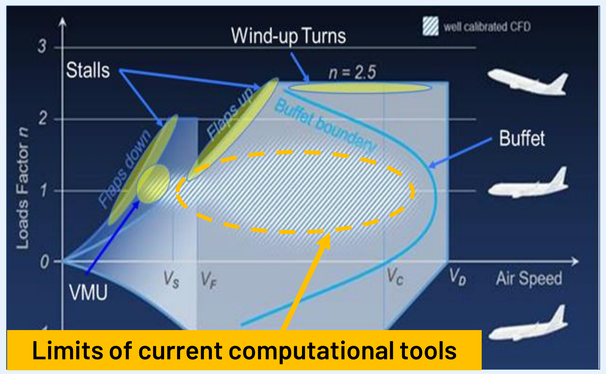
- Many flight maneuvers occur at the edges of the flight envelope and the available computational tools are not able to predict the associated complex flow phenomenon accurately
- There is a need to develop validated computational tools that can provide flight prediction that is equal in accuracy to certification flight tests
- NASA is sponsoring research to develop computational tools that are Robust, Cost-effective and Accurate (RCA)

Expected Impacts

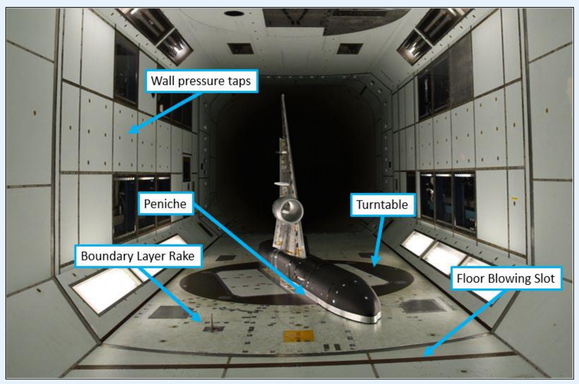
- Efficient and optimized certification process
- Discover and eliminate performance surprises typically found during flight test
- Accelerate product development schedule and time-to-market
- Potential for huge cost savings in aircraft development programs (100s of million dollars)
- Analysis capabilities for concept & configuration development ~~lead~~ to better designs, contributing to aviation sustainability



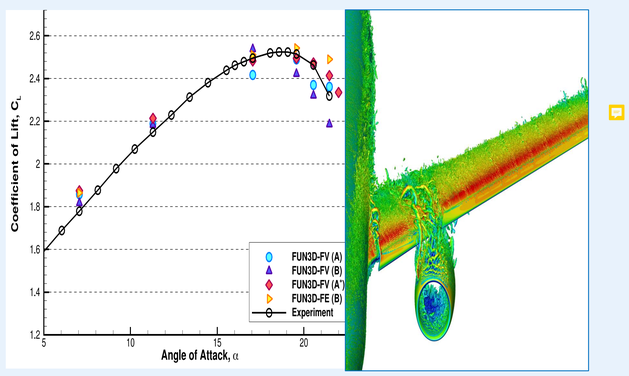
A 20-year research roadmap to enable CbA



Prediction tools needed near edges of the flight envelope



Experiments provide tools validation data



WMLES provides accurate prediction of C_{Lmax}

Solution

- Use wall-modeled large eddy-simulation (WMLES), which models the very near wall flow but resolves large scale flow structures in the flow
- This approach is expected to provide better prediction near the edges of the flight envelop (in, particular aircraft stall), where flow separation occurs
- Implement WMLES in computational fluid dynamics (CFD) tools
- Conduct wind tunnel experiments to provide high-quality data for validation of CFD tools

Results

- Implemented WMLES in two NASA CFD codes: FUN3D and LAVA
- High-lift experiments to determine maximum lift (C_{Lmax}) have been conducted at a ~~give~~ Reynolds number
- WMLES provides accurate prediction of C_{Lmax}, which is critical for predicting stall

Next Steps

- Additional experiments are planned to provide validation for a range of parameters applicable to flight
- Assess the efficacy of WMLES for these test conditions
- Include prediction of the effect of icing on C_{Lmax}
- Engage with FAA and industry for acceptance of alternative means of compliance for flight certification

Partners

- Boeing, collaborating in experiments and assessment of CFD tools
- AIAA, organizing high-lift prediction workshops to engage wider community in assessment of C_{Lmax} prediction capability
- High-lift echo system that includes NASA, Boeing, DLR, ONERA, JAXA, KHI, to provide experimental data for tool validation

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IMAGINAVIATION